Dec. 9, 1969 R. S. BERGLUND 3,483,427

LENS FOR ELECTRON BEAM RECORDER

Filed Nov. 3, 1967

FIG. 1

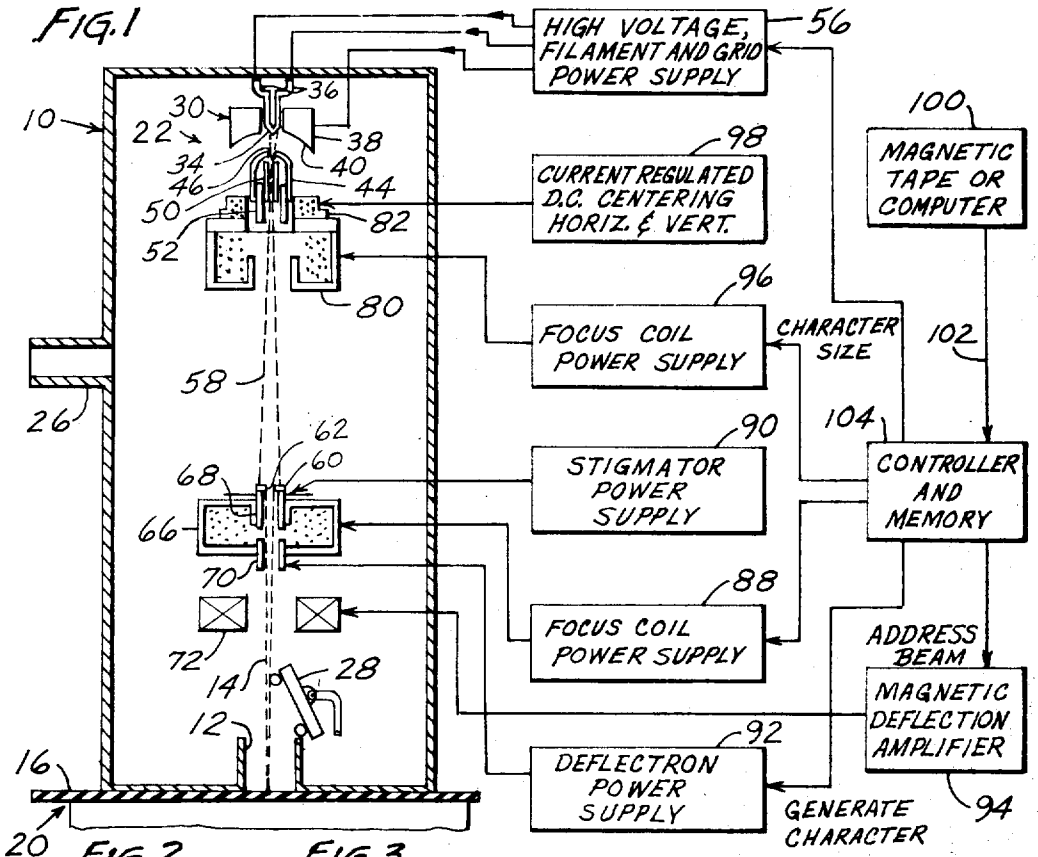


FIG. 2

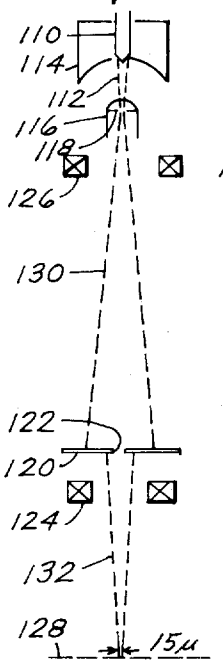


FIG. 3

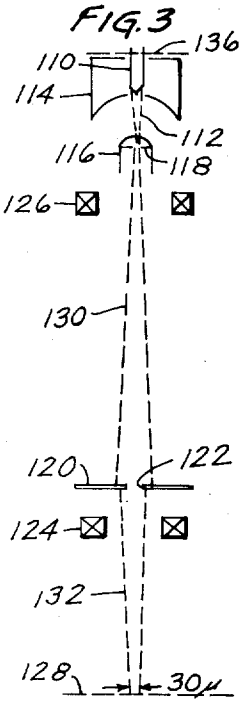


FIG. 5

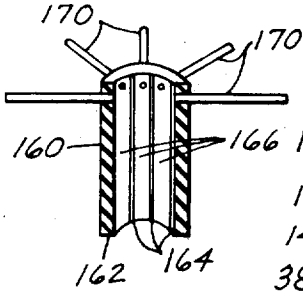
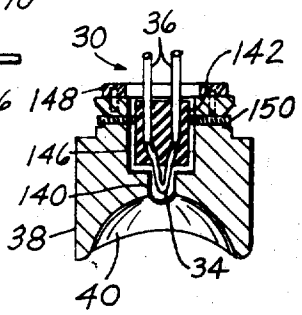


FIG. 4



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LENS FOR ELECTRON BEAM RECORDER

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U.S. Cl. 315—31 11 Claims

ABSTRACT OF THE DISCLOSURE

An electron beam recorder wherein two focusing coils are positioned for varying the current density and the cross-sectional area of the electron beam, an apertured plate is positioned between the focusing coils for passing only the central portion of the electron beam, and a programmed electrical circuit is operatively coupled to the electron beam source and the focusing coils for selectively varying the electron beam current, current density and cross-sectional area in order to maintain at the recording surface a predetermined current density of electron beams having differing cross-sectional areas.

Electron beam recorders for imaging characters on an electron sensitive media are known. In certain electron beam recorders, characters of different sizes may be recorded. Position or addressing of an electron beam onto a particular location on the media is provided by known deflection circuitry. When small size characters are recorded on an electron sensitive media, a single focusing device focuses the electron beam to a single predetermined cross-sectional area or spot size. When single characters are recorded, the current density of the electron beam at a predetermined spot size is maintained at a predetermined density by any one of several known techniques.

When large size characters are recorded on an electron sensitive media, the electron beam is deflected over and images a larger surface of the media relative to that imaged for an electron beam for a smaller character. Sufficient electron beam current density for imaging the media is obtained by increasing the electron beam current from an electron gun source. For example, when the electron beam is to record a character which is doubled in size, the electron beam cross-sectional area or spot size and current density should increase four-fold. Such an increase in both spot size and density is necessary to maintain a uniform relationship between line width and character size of the recorded images.

When the electron beam current produced by the electron gun is substantially increased in current density, say by a factor of four, certain inherent problems are encountered. For example, if a filament is operated at a higher emission level, it is usually necessary to increase the filament temperature which in turn shortens filament life. Filament life is inversely proportional to filament emission density. Thus, a filament operated at a higher filament temperature and relatively high emission density usually must be replaced at more frequent intervals than filaments operated at a lower temperature and lower emission density. Another inherent problem of operating the filament at higher temperatures is that the increased amount of thermal energy must be dissipated by the electron gun. Further, the power supply and associated circuitry must be designed to operate at higher current levels.

It is also known in the prior art to utilize a plurality of focusing lens, such as for example U.S. Patent No. 2,898,467. The focusing lens reduce the electron beam spot size or cross-sectional area to a diameter of less than 2μ to produce and maintain an extremely fine writing

spot for recording oscillographic curves on a photographic media.

The present invention discloses a unique and novel apparatus and method for using at least two focusing lens for selectively varying an electron beam spot size or cross-sectional area while maintaining the electron beam current density at substantially a predetermined current density. In one embodiment of the present invention, the two focusing means are utilized for imaging an electron sensitive recording media with characters of two different sizes. By using the teachings of the present invention, the electron beam cross-sectional area at the surface of the media can be selectively increased four-fold while the electron beam current need be increased only two-fold.

One advantage of the present invention is that the electron beam spot size or cross-sectional area can be electrically switched between two predetermined cross-sectional areas at high switching rates.

Another advantage is that an electron beam recorder utilizing the teachings of this invention can image an electron sensitive media with characters having a plurality of sizes.

A further advantage of the present invention is that a new method is taught for selectively varying the cross-sectional area of an electron beam while maintaining the current density thereof at substantially a predetermined density.

Another advantage of the present invention is that apparatus is disclosed which is responsive to digital signals for recording, with an electron beam on an electron sensitive media, characters of at least two sizes.

These and other advantages will become apparent when considered in light of the following detailed description of a preferred embodiment taken together with the drawing wherein:

FIGURE 1 is a pictorial representation partially in block form of an electron beam recorder utilizing the teachings of the present invention;

FIGURE 2 is a diagrammatic representation of the electron beam path for recording characters of small size on an electron sensitive media with an electron beam having a spot size in the order of 15μ;

FIGURE 3 is a diagrammatic representation of the electron beam path for recording characters of large size on an electron sensitive media with an electron beam having a spot size in the order of 30μ;

FIGURE 4 is an isometric view partially in section illustrating a grid-filament assembly capable of being used in the electron beam recorder of FIGURE 1; and

FIGURE 5 is an isometric view partially in section illustrating a stigmator capable of being used in the electron beam recorder of FIGURE 1.

Briefly, the electron beam recorder, apparatus and method of the present invention includes in combination a means for discretely controlling the cross-sectional area of a modulated electron beam while maintaining a substantially uniform current density for imaging an electron sensitive media. In one embodiment, a vacuum chamber has at one end thereof an electron gun for generating an electron beam. Located at the other end of the chamber is an electron sensitive media which is adapted to be imaged by the electron beam and the media is positioned along a predetermined path in alignment with the electron gun. Means are provided for defining an aperture and the aperture defining means is positioned along the predetermined path for passing substantially the central portion of the electron beam to form an electron beam of uniform diameter. A first focusing means is positioned along the predetermined path and relative to the means defining an aperture for focusing the central portion of the electron beam on the media. A second focusing means is positioned adjacent the electron gun and is capable of

being selectively energized for focusing the electron beam to a smaller uniform diameter. The first focusing means is operative to focus the central portion of the electron beam at a first predetermined cross-sectional area and predetermined density on the media when the second foucsing means is de-energized. Also, the first focusing means is operable to focus the central portion of the electron beam at a larger second predetermined cross-sectional area when the second focusing means is selectively energized. When the first focusing means focuses the central portion of the electron beam at the second predetermined cross-sectional area, the current density thereof can be made substantially equal to the predetermined current density by doubling the electron beam current each time the focused electron beam cross-sectional area is doubled.

FIGURE 1 illustrates, in a pictorial representation, an electron beam recorder incorporating the teachings of the present invention. The electron beam recorder includes an electron gun chamber, generally designated as **10**, which terminates in an imaging aperture **12**. A focused electron beam **14** is deflected onto and images an electron sensitive media **16**. The electron sensitive media **16** is positioned in communication with the imaging aperture **12** through a slot-type vacuum seal, generally designated as **20**.

A vacuum seal adapted for use with an electron beam recorder is described in a copending application filed Nov. 3, 1967, U.S. Ser. No. 684,096, entitled Corpuscular Beam Recorder invented by Earl K. Hoyne. In one embodiment, the electron sensitive media was selected to be dry silver film having a Mylar backing such as that described in Belgium Patent No. 663,112. Alternatively, the photographic film could be a high resolution, grain-free spectroscopic film, such as Kodak type 649–GH.

The electron gun chamber **10** has an electron gun, generally designated as **22**, at one end thereof. At the other end of the electron gun chamber **10** and generally in alignment with the electron gun **22** is the imaging aperture **12**. The electron gun chamber **10** is maintained at a predetermined vacuum level, such as for example 10^{-5} torr, by means of a vacuum pump (not shown) operatively connected to the electron gun chamber **10** through conduit **26**. The vacuum within the electron gun chamber **10** can be maintained during loading of the photographic media by use of a flap valve **28**.

The electron gun **22**, in one embodiment, comprises a removable filament-grid assembly **30**. The filiment-grid assembly **30** includes a filament **34** which is supported by support conductors **36**. The filament **34** is supported within a grid **38**. The grid **38** is in the form of a solid spherical member having an aperture therethrough into which the filament **34** is inserted. The outer surface of the grid **38** is in the form of a concave spherical-shaped surface **40**. The filament-grid assembly **30** is illustrated in greater detail in FIGURE 4. A mating cylindrical anode **44** is positioned a predetermined distance from the spherical surface **40** of grid **38**.

The anode **44** forms an aperture **46** therein through which an electron beam passes. Within the interior of anode **44**, a focusing slot **50** having a focusing aperture receives electrons emitted by filament **34** which have passed through the aperture **46**. The anode **44** and slot **50** are threaded and supported by a threaded support member **52**.

The filament and grid are energized by a high voltage filament and grid power supply **56**. In one embodiment, the filament is maintained at a voltage of about −21 kv., the grid at about −21.3 kv. and the anode **44** at ground potential. In this embodiment, the anode **44** is spaced about .45 inch (about 12 mm.) from the grid **38**. The aperture in the grid **38** is about .1 inch (about 2.5 mm.), the anode aperture **46** is about .035 inch (about 1 mm.) and the aperture in the slot **50** is about .0015 inch (about 37.5μ).

Electrons from the filament **34** are directed through the aperture **46** by an accelerating field existing between the grid **38** and anode **44**. The electrons from the filament **34** are substantially directed to a point at the focusing aperture of slot **50**. The electron beam emanates from the focusing aperture of slot **50** through the support member **52** and spreads into a conical-shaped beam **58** as it passes down the center of the electron gun chamber **10**.

It is contemplated that the present invention could be utilized in combination with electron guns which produce the electron beam in discrete patterns rather than in a spot. For example, the electron beam can be used in a character generator electron gun for generating a predetermined character. In particular, the electron beam can be used to flood a mask having the character formed therein such that the electron beam passing therethrough has a cross-sectional size which is in the form of the character mask.

Means defining an aperture, such as for example an aperture plate **60**, is positioned at any one of many desired locations at a predetermined distance from the anode **44**. The aperture plate **60** has an aperture therethrough, generally designated as **62**. The central portion of the conical-shaped electron beam **58** passes through aperture **62** and is formed into an electron beam of a desired diameter. The central portion of the electron beam **58** is focused into a focused electron beam **14** which is ultimately used to image the electron sensitive media **16**.

A first focusing means, such as for example a magnetic focusing means **66**, is positioned relative to the aperture plate **60** between the aperture **62** and the media **16**. The magnetic focusing means **66** focuses the central portion of the electron beam **58** into a thin focused electron beam **14** having a predetermined spot size. In one embodiment, the aperture **62** is selected to have a diameter of about .1 inch (about 2500μ) and is preferably positioned just before the magnetic focusing means **66**. The magnetic focusing means **66** ultimately focuses the electron beam to a cross-sectional area of 15μ which electron beam may have a predetermined current density in the order of about .5 amp/cm.^{2} to about 1 amp/cm.^{2}.

A stigmator **68** is used to correct for irregularities in beam cross-sectional area. A deflectron **70** is used to stroke or selectively deflect the electron beam **14** in a predetermined character pattern which is ultimately imaged on the electron sensitive media.

A deflecting means, such as for example a magnetic deflection coil **72**, is used to address or position the focused electron beam **14** onto a predetermined area of the electron sensitive media **16**. The deflectron **70** then selectively deflects or strokes the electron beam in small discrete strokes to image a character onto the predetermined area on the media **16**.

A second focusing means, such as for example magnetic focusing means **80**, is positioned adjacent the anode **44** and along the predetermined path between the electron gun **22** and the media **16**. The magnetic focusing means **80** when energized causes the conical-shaped electron beam **58** to be focused to a smaller uniform diameter at the aperture plate **60**.

A direct current centering means, such as for example a centering coil **82**, is used to center the electron beam **58** onto the aperture plate **60**.

The magnetic focusing means **66** is controlled by a focus coil power supply **88**. The stigmator **68** is energized by a stigmator power supply **90** and by proper adjustment of the stigmator **68** the cross-section of the electron beam can be made to be nearly circular in cross-section. The deflectron **70** for generating a character is controlled by deflectron power supply **92**. The deflection coil **72**, for addressing the electron beam **14** to a predetermined position on the media **16**, is supplied from a magnetic deflection amplifier **94**. The magnetic focusing means **80** is energized and controlled by a focus coil power supply **96**. The

direct current centering coil **82** is controlled by a current regulated power supply **98** which maintains both the horizontal and vertical centering position of the electron beam **58** after the same has been selectively adjusted onto the aperture plate **60**.

In one embodiment, the electron beam recorder was used as a device for converting information from a magnetic tape into a permanent record onto a photographic film. Alternatively, the electron beam recorder could be connected directly to a computer as an output device. In any event, the output from either a magnetic tape or a computer, designated by box **100**, is in a digital format. The digital signals appear on an input **102** and are applied to a controller and memory unit **104**. The controller and memory unit **104** in turn controls various components on the electron beam recorder to record information onto the electron sensitive media **16** in the form of characters of a predetermined size.

The cross-section of the focused electron beam **14** is discretely controlled for generating and recording characters of a predetermined size onto the electron sensitive media **16**. The controller and memory unit **104** initially addresses the focused electron beam **14** to a predetermined position on the electron sensitive media **16**. A programmed direct current voltage is applied to the deflection amplifier **94**. The amplifier **94** in turn applies a deflection current to coil **72** to deflect the focused electron beam **14** onto the addressed location on the media **16**. If the character to be recorded is of a small size, the controller and memory unit **104** de-energizes the power to the focus coil power supply **96** disabling the magnetic focusing means **80**. The focus coil power supply **88** to the magnetic focusing means **66** is set at a predetermined level focusing the electron beam **14** to a small diameter, such as for example a 15μ diameter. Thereafter, the controller and memory unit **104** programs the deflectron power supply **92** with electrical signals representing a character pattern. The electrical signals, in the form of discrete voltage levels, are applied to deflectron **70** which establishes an electrostatic field for deflecting the focused electron beam **14**. The deflected electron beam generates a character, such as for example a graphic symbol, a letter or a number, which is subsequently imaged onto electron sensitive media **16** at the addressed position of the focused electron beam **14**. In one application, the electron beam having a 15μ cross-sectional area is capable of generating a 120μ character with an electron beam current density of about .5 amp/cm.^{2}. Also, since the electron beam current density can be doubled for recording larger size characters, if desired the electron beam density at the small character size can be doubled to about 1 amp/cm.^{2} without increasing the electron beam spot size for imaging a character on the electron sensitive media at a higher density.

If the controller and memory unit **104** determines that a large character is to be recorded on the media **16**, certain changes are electrically made in the electron beam recorder. Specifically, the focus coil power supply **96** is energized causing the magnetic focusing means **80** to decrease the cross-sectional diameter of the conical-shaped electron beam **58**. Also, if desired, the focus coil power supply **88** can be slightly decreased in power which slightly decreases the focusing action of the magnetic focusing means **66**.

The controller and memory unit **104** then programs the deflectron power supply **92** and subsequently the deflectron **70** to generate the desired large character. Concurrently, the controller and memory unit **104** programs the high voltage, filament and grid power supply **56** to increase the current level of the electron beam produced from the filament **34**.

In one embodiment, the beam cross-sectional diameter of focused electron beam **14** was increased from 15μ to 30μ thereby increasing the beam diameter two-fold. When the magnetic focusing means **80** is energized, the beam current density appearing at aperture **62** is substantially increased in magnitude. Similarly, by doubling the current density of the electrons produced in filament **34**, the resulting cross-sectional diameter of focused electron beam **14** has a cross-sectional area which is approximately four times as large as that utilized for a small character and at substantially the same predetermined current density as the electron beam for the small character. However, the current level of the electron beam from the electron gun is only doubled in magnitude even though approximately four times the current density was required at the surface of the electron sensitive media **16**. In one application, the electron beam having a 30μ cross-sectional area is capable of generating a 240μ character with an electron current density of about .5 amp/cm.^{2}.

FIGURES 2 and 3 are diagrammatic representations of the focusing action of the lens illustrated in FIGURE 1 for maintaining the electron beam current density at substantially the same level for various beam diameters.

In FIGURES 2 and 3, a filament **110** produces electrons **112** which are directed by means of a grid **114** through an anode **116** onto a slotted member **118** having an opening therein which permits electrons to pass therethrough which form an electron beam of uniform diameter. An aperture plate, designated by **120**, has an opening therein, designated as **122**. The first focusing means is designated as **124** and the second focusing means is designated as **126**. In one embodiment, the aperture plate **120** is positioned approximately 14.75 inches (about 37.5 mm.) from the opening in the slotted member **118**. The first focusing means **124** is positioned approximately 17.125 inches (43.5 mm.) from the slotted member **118**. The recording media **128** is positioned approximately 6.75 inches (about 17 mm.) from the first focusing means **124**. In this embodiment, each of the focusing means **124** and **126** includes a magnetic focusing coil. The focusing coil for focusing means **124** has a focal length which varies between 4.3 and 4.9 and the focusing coil for focusing means **126** has a focal length of 7. The spherical aberration constant of each of the lens is selected to be as small as possible and in this embodiment was **147**.

FIGURE 2 illustrates the electron beam characteristics for generating a small character. The electrons **112** passing through the slotted member **118** diverge into a conical-shaped electron beam **130** which floods or bombards the aperture plate **120**. In the above-noted embodiment, the electron beam cross-section is about .25 inch (about 6250μ) at the aperture plate **120**. The opening **122** in this embodiment is about .1 inch (about 2500μ) and the focused electron beam **132** is focused by the first focusing means **124** to a cross-section of about 15μ at the surface of the electron sensitive media **128** to image thereon a character about 120μ in size. The object of the first focusing means **124** is substantially the electrons in the opening of the slotted member **118**.

FIGURE 3 illustrates the electron beam characteristics for generating a large character. The second focusing means **126** is energized to focus the beam to a cross-sectional of about .1 inch (about 2500μ) at the aperture plate **120**. The first focusing means **124** may be, but need not necessarily be, slightly reduced in power, such as for example a decrease in power level of less than five percent. The focused electron beam **132** then has a cross-section in the order of 30μ at the surface of the electron sensitive media **128**. The object for the first focusing means **124** is a virtual image which appears to be approximately 3.5 inches (about 8.75 mm.) behind the slotted member **118** at approximately the location illustrated by dashed line **136**. The virtual image for this lens is in the order of two times that of the image which appears at the opening in slotted member **118**.

Concurrently, when the second focusing means **126** is energized focusing the conical-shaped electron beam **130**, the grid bias of grid **114** is adjusted such that the density of electrons from filament **110** reaching the anode **116** is doubled for approximately a four-fold increase in the

cross-sectional area of the focused electron beam **132**. By use of the second focusing means **126** to slightly focus the conical-shaped electron beam **130** in FIGURE 3 to a smaller beam cross-section, a larger portion of the electron beam current density at the original power level is used. The additional electron current density is obtained by adjusting grid bias. In this manner, the current density of the electron beam at the larger cross-sectional area of, say, 30μ is substantially the same predetermined current density as the electron beam for the 15μ spot.

FIGURE 4 is an isometric representation of the filament-grid assembly **30** of FIGURE 1 partially in cross-section. The grid **38** is a cylindrical-shaped grid constructed of a nonmagnetic stainless steel, such as for example #302 or #304. The grid **38** has an aperture **140** therethrough along the center axis thereof which terminates in and communicates with a grid hollowed-out area **146**. The other end of the grid **38** terminates in a spherical concave inner surface **40** which communicates with the aperture **140**. The filament **34** can be constructed from a relatively thin tungsten wire which is electrically connected to a pair of conductors **36**, which in one embodiment were copper electrodes. The conductors **36** and filament **34** are rigidly supported by an insulating cylindrical-shaped support **142**. Support **142** may be formed of an insulating material, such as Supermica 500 sold by the Mycalex Corporation of America. The support **142** has a dimension which is less than that of the grid hollowed-out area **146**. Thus, the insulating support **142**, the filament **34** and conductors **36** together form an integral unit which can be located within the grid hollowed-out area **146**. The filament **34** is of sufficient length to extend through the aperture **140** so as to be adjacent the spherical concave inner surface **40**. The filament **34** may be selectively located within the aperture below surface **40**, even with surface **40** or extending out of aperture **140** slightly beyond the surface **40**.

A cover plate **148** having at least one opening for receiving the conductors **36** is secured to the grid **38** at the grid hollowed-out end **146** by means of fasteners, such as for example screws. The filament **34** can be properly aligned within the aperture **140** by means of four adjusting screws **150** which are located at 90° angles around the periphery of the grid **38**.

The entire filament-grid assembly **30** is a pluggable unit which can be used in an electron gun or for an electron beam source.

FIGURE 5 is an isometric view of stigmator **68** of FIGURE 1 partially in cross-section. In FIGURE 5, machineable cylindrical-shaped insulating member **160**, for example formed of Supermica 500, is illustrated. The member **160** has an aperture therethrough forming an inner surface forming relatively thin outer walls **162** around the periphery of member **160**. The interior of the cylindrical-shaped member **160** is coated with a relatively thin metallic coating, such as vapor coated, having a thickness in the order of several microns. The metallic coating on member **160** is then scribed with a plurality of parallel lines **164** forming a plurality of parallel segments **166** which extend longitudinally to and in a spaced relationship from the longitudinal axis of the cylindrical-shaped member **160**. In one embodiment, eight separate segments were formed as a stigmator.

A plurality of electrical conductors **170**, such as for example copper leads, are rigidly mounted into and extend through the thin outer wall **162** to be mechanically and electrically connected to the segments **166**. In one embodiment, the copper leads are threaded and the cylindrical-shaped member **160** has a plurality of spaced apertures which are tapped to provide a rigid mechanical connection between the copper leads and the cylindrical shaped member **160**. Thus, at least one segment **166** is electrically connected to a lead **170**. Further, each segment is spaced from and electrically isolated from each other segment. Thus, each segment **166** is capable of having a predetremined potential applied thereto for correcting astigmatism in the electron beam cross-sectional area. The resulting stigmator is operated in a manner similar to that used for stigmators known in the art. Such a stigmator is a compact economical device which can be used in an electron beam recorder for imaging a photographic media with an electron beam.

Alternately, the stigmator cylindrical-shaped member could be formed of a standard ceramic-type material, such as Alsimag 719 manufactured by the American Lava Corporation. By utilizing known techniques, a thin copper coating can be coated onto the interior of the ceramic member in a pattern to form a plurality of electrically isolated copper segments. The copper leads can be fused onto the ceramic material and electrically connected to the copper segments.

It is apparent that certain modifications, improvements and the like can be made of the present invention and all are deemed to be within the scope of the appended claims.

What is claimed is:

1. In apparatus which is responsive to digital signals for recording with an electron beam on an electron sensitive media characters of at least two sizes, means for discretely controlling the spot-size of said electron beam while maintaining the current density thereof at substantially a predetermined current density during imaging of said media with said characters, said means comprising:

means defining an aperture positioned to intercept said electron beam to form from the central portion thereof an electron beam of a desired diameter;

a first focusing means positioned relative to said aperture defining means for focusing said central portion of said electron beam on said media, said first focusing means being selected to have a focal length wherein said central portion of said electron beam is focused to a first predetermined spot size which is capable of being deflected in a character pattern for imaging said media with a character of a first size;

a second focusing means positioned before said first focusing means and adjacent said modulated electron beam, said second focusing means being selected to have a focal length wherein said central portion of said electron beam is focused to a smaller diameter which changes the focusing of said first focusing means in a manner to increase said central portion of said electron beam to a larger second predetermined spot size which is capable of being deflected in said character pattern for imaging said media with said character at a second size; and

programming means responding to said digital signals for determining a character and the size of said character which is to be imaged on said media and for controlling deflection of said focused electron beam in said character pattern, said programming means being capable of controlling said second focusing means for producing said first predetermined spot size when said character pattern is to be imaged on said media at said first size and for producing said second predetermined spot size and increasing the electron beam current intensity to a level wherein the current density of said electron beam spot on said media at said second predetermined spot size is substantially equal to the current density at said first predetermined spot size when said character pattern is to be imaged on said media at said second size.

2. The apparatus of claim **1** wherein said means defining said aperture is positioned just before said first focusing means and said electron sensitive media is a photographic film.

3. The apparatus of claim **2** wherein said first focusing means and said second focusing means include magnetic focusing coils and wherein said first predetermined spot size is selected to be about 15μ and said second predetermined spot size is selected to be about 30μ.

4. A method for selectively varying the cross-sectional area of an electron beam on a surface between two predetermined cross-sectional areas while maintaining the current density thereof at substantially a predetermined current density comprising the steps of:

generating an electron beam having a selected current level;

directing said electron beam along a predetermined path;

selectively passing the central portion of said electron beam to produce an electron beam of uniform diameter;

focusing said central portion of said electron beam tc a first predetermined cross-sectional area at said predetermined current density on said surface;

focusing said electron beam to a smaller uniform diameter when said electron beam cross-sectional area is to be selectively increased resulting in said central portion of said electron beam being focused to a larger second predetermined cross-sectional area on said surface;

increasing the current of said electron beam when said focused electron beam cross sectional area is at said second predetermined cross-sectional area to a level wherein the current density thereof substantially equals said predetermined current density; and

programming said focusing of said electron beam to a smaller uniform diameter and said increasing of said electron beam current level for selectively switching said electron beam on said surface between said two predetermined cross-sectional areas.

5. The method of claim 4 wherein said surface is part of an electron sensitive media further comprising the steps of:

deflecting said focused central portion of said electron beam having a predetermined cross-sectional area onto a preselected position on said surface; and

selectively stroking said deflected electron beam in a character pattern to image a character on said media.

6. An apparatus for selectively controlling the cross-sectional area of an electron beam at a surface while maintaining at the surface a predetermined current density of the electron beam comprising:

means for generating a said electron beam of variable current;

means for selectively focusing the generated electron beam to vary the current density of the electron beam;

means for passing the central portion of the focused electron beam;

means for focusing the passed central portion of the electron beam to a desired cross-sectional area at the surface; and

programming means controlling the generating means and both focusing means for selectively simultaneously increasing the current of the generated electron beam, focusing the generated electron beam to increase current density, and focusing the passed central portion of the electron beam to a desired larger cross-sectional area at the surface, while maintaining at the surface, the predetermined current density.

7. The apparatus according to claim 6 further comprising means for deflecting the passed central portion of the electron beam onto an addressed location on the surface.

8. The apparatus according to claim 6 further comprising means for selectively stroking the electron beam in a character pattern to image a character on the surface.

9. An electron beam recorder for recording multisize character patterns on a media surface, with an electron beam having a maintained predetermined current density at the media surface comprising:

a variable current electron beam source;

a plate defining an aperture for passing the central portion of a said electron beam to a said media surface;

a first focusing means located between the plate and the position of a said media surface for controlling at a said media surface the cross-sectional area of the passed central portion of a said electron beam having a predetermined current density at a said media surface;

a second focusing means located between the electron beam source and the plate for controlling the current density of a said electron beam at the aperture; and

a programming circuit controlling the electron beam source and the first and second focusing means for selectively simultaneously increasing electron beam current, operating the second focusing means to increase the current density of the electron beam at the aperture and operating the first focusing means to provide at a said media surface a desired larger electron beam cross-sectional area and the predetermined electron beam current density.

10. The electron beam recorder according to claim 9 further comprising deflection means located between the first focusing means and the position of a said media surface and operatively coupled to the programming circuit for deflecting the passed central portion of the electron beam to an addressed location on a said media surface in response to a programmed signal received from the programming circuit.

11. The electron beam recorder according to claim 10 characterized by a deflectron located between the first focusing means and the position of a said surface media and operatively coupled to the programming circuit for discretely stroking the passed central portion of the electron beam in a character pattern in response to a signal representative of a character pattern received by the programming circuit to image the media surface with a said character pattern at the addressed location.

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